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Protection Branch Report of Test No. 1-64

Microbial Contamination Obtained on Surfaces Exposed to Room Air or Touched by the Human Hand

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A study to determine the level of microbial contamination that can be expected to accumulate on a surface was conducted in order to obtain an experimental basis for estimating microbial contamination on a spacecraft. Hobby* calculated that 2×10^8 viable microorganisms would accumulate in 90 days on a spacecraft with a surface area of 100 square feet. This figure was calculated by first determining the rate of fallout of viable microorganisms (840/sq ft/hr) during the assembly and test of the Ranger spacecraft. However, only through experimentation can one determine how many microorganisms that fall from the air onto a surface will remain viable. In addition to the contamination acquired by the airborne route, the human hand, touching or handling the spacecraft, may also contribute microorganisms. In the present experiments, surfaces, used to simulate those of a spacecraft, were exposed to room air for various time periods; also other such surfaces were touched or handled by the human hand. The microbial recoveries obtained from surfaces exposed to these two routes are reported herein.

MATERIALS AND METHODS

Sterile stainless steel strips (1 x 2 inches) were exposed to room air for various time periods ranging from one day to 103 days. Half of the strips were placed in a horizontal position on a clean decontaminated shelf; the rest were placed in a vertical position on the same shelf. At each exposure period, five strips from each position were placed in individual distilled water blanks with the aid of sterile forceps. The samples were shaken and assayed for viable microorganisms by the pour plate method using tryptose agar as culture medium. Colony counts were made after the plates had incubated at 37 C for 48 hours. Four tests conducted during the past eight months comprised this experimentation.

* Jet Propulsion Laboratory Interoffice Memo to M. Communtzis from G. Hobby, "Sterilization Criteria for Mariner Spacecraft Design", 3 January 1962.

Human volunteers briefly handled or touched both sterile stainless steel strips and sterile electronic components (resistors) with their fingers, then each placed the object in an individual bottle containing Tween 20 solution. The bacteriological assays were then conducted in the manner described above.

The rate at which viable microorganisms fall out of the air onto a surface was also determined. Fifteen sterile tryptose agar plates (equivalent to one square foot) placed at each of three positions (horizontally on the floor, horizontally on the bench top and vertically on the bench top) were exposed to the air for 100 minutes. This determination was done several times each month during the past ten months.

RESULTS AND DISCUSSION

Microbial recovery (per square foot area) from stainless steel strips after exposure in horizontal and vertical positions are summarized in Figures 1 and 2. The data clearly indicate that more viable microorganisms from the air fall on a horizontal surface than on a vertical surface. Over a three month period, the microbial population on the steel, positioned either horizontally or vertically, seemed to build up to a certain level and then remain fairly constant.

The results obtained after handling or touching surfaces are given in Table I, II and III. The number of microorganisms recovered from stainless steel strips and electronic components varied from day to day for any one volunteer as well as among the volunteers (Table I). The person, rather than the type of surface, probably determines the amount of microbial contamination present after handling. Table II shows that 64 per cent of the volunteers left very few microorganisms upon handling the steel while 8 per cent of the volunteers greatly contaminated the steel. Microbial contamination may increase greatly if the fingers are put into the nostrils before handling an object (Table III). Similar results would probably be obtained with a person who is afflicted with a cold, and is frequently wiping his nose.

The number of microorganisms that fall from the air onto a square foot of agar surface in an hour is summarized, according to the month of the year, in Figure 3. The greatest number of microorganisms was collected on the agar plates that were on the floor; at bench top level, the number was slightly decreased when the agar plates were in horizontal position and greatly decreased when the agar plates were in a vertical position.

It is evident that, in a room, thousands of viable microorganisms fall on a square foot of horizontal surface per day; however most of these microorganisms die rapidly. The viable count builds up to a certain level and then appears to remain more or less constant. Therefore, the maximum viable microbial contamination expected on a spacecraft (100 square feet in area) is probably a few orders of magnitude lower than Hobby"s estimate calculated with the assumption that all microorganisms reaching the surface would remain viable.

It is also possible that some individuals could contribute as much microbial contamination by merely touching the spacecraft as collects through the airborne route. A substantial decrease in microbial contamination may be obtained by assemblying the spacecraft in a "clean room" provided that the personnel assigned to the project employ strict "clean room" techniques. It should be mandatory for the personnel assembling a spacecraft to wear gloves also wear a mask. By taking precautions to keep the microbial population as low as possible, the probability of obtaining a sterile spececraft with a given sterilization procedure is increased since the percentage of microorganisms killed in a given time is the same regardless of the initial number present.

Table I.

Microbial Contamination on Stainless Steel Strips and Electronic Components After Handling with Fingers

Volunteer	Microorganisms/Stainless Steel Strip			
	2-11-63	2-13-63	2-15-63	5-27-63
DRS	19	11	15	76
CLM	3	22	31	36
MED	19	52	50	--
DMP	11	5	1	1
RRJ	27	--	30	--

Volunteer	Microorganisms/Electronic Component	
	2-14-63	2-15-63
DRS	262	1
CLM	2760	291
MED	50	99
DMP	1	--

Table II.

Frequency Distribution of Microorganisms on Stainless Steel Strips After Handling

Number Microorganisms per Strip	Number Volunteers*	Percentage
1 - 20	16	64
20 - 40	5	20
40 - 60	2	8
Over 1000	2	8

* A total of 25 volunteers participated in the test.

Table III.

Microbial Contamination on Stainless Steel Strips After Handling with Fingers Which Had Been Inserted in the Nostrils

Volunteer	Microorganisms/Strip	
	Before	After
JFS	3330	9,400
DRS	76	826
CLM	36	46
DMP	1	15,900

Before = Recovery after normal handling.

After = Recovery after fingers had been inserted in the nostrils.

Figure 1. Recovery of Microorganisms from Air Exposed Stainless Steel Strips After Various Time Periods in a Horizontal Position

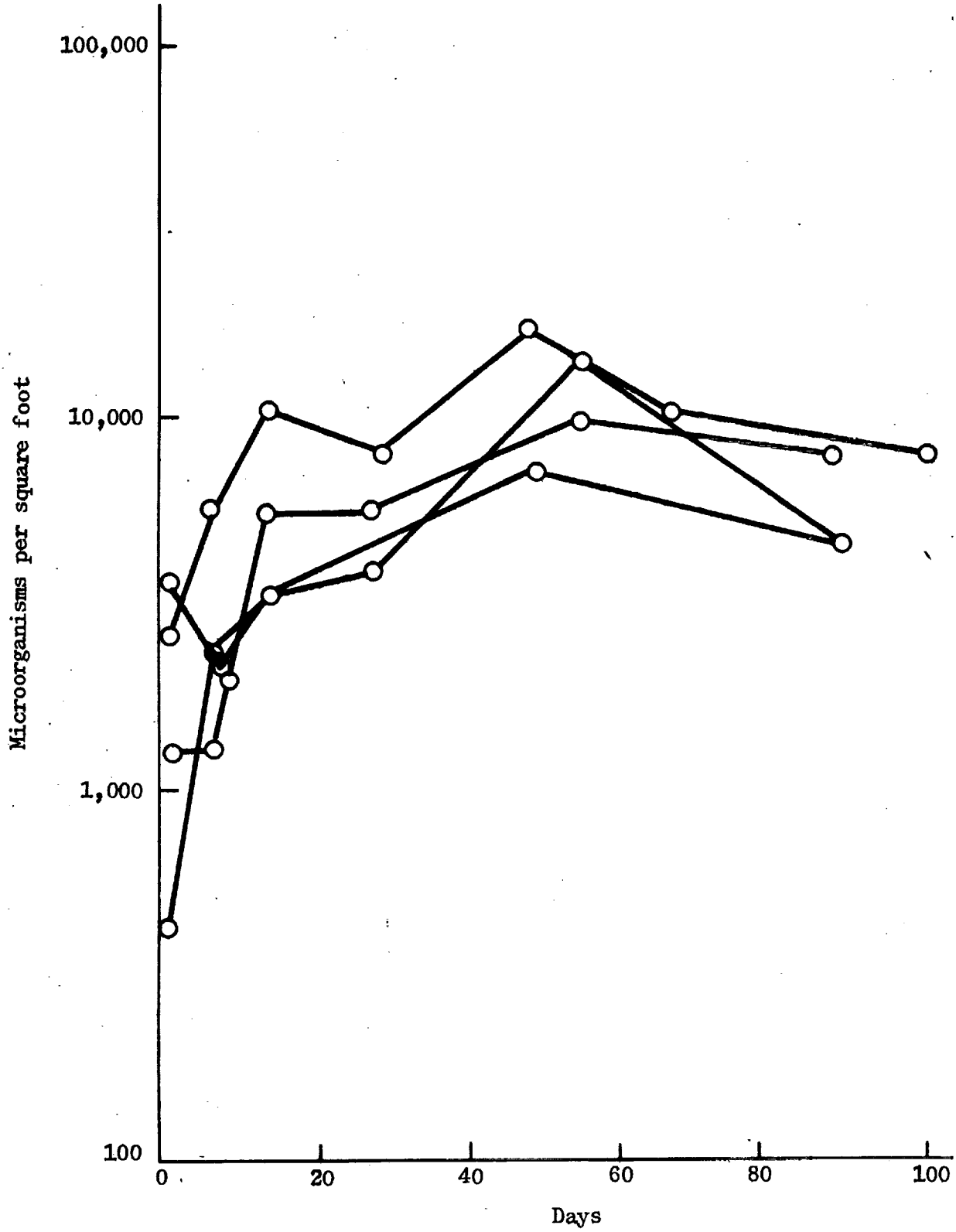

Figure 2. Recovery of Microorganisms from Air Exposed Stainless Steel Strips After Various Time Periods in a Vertical Position

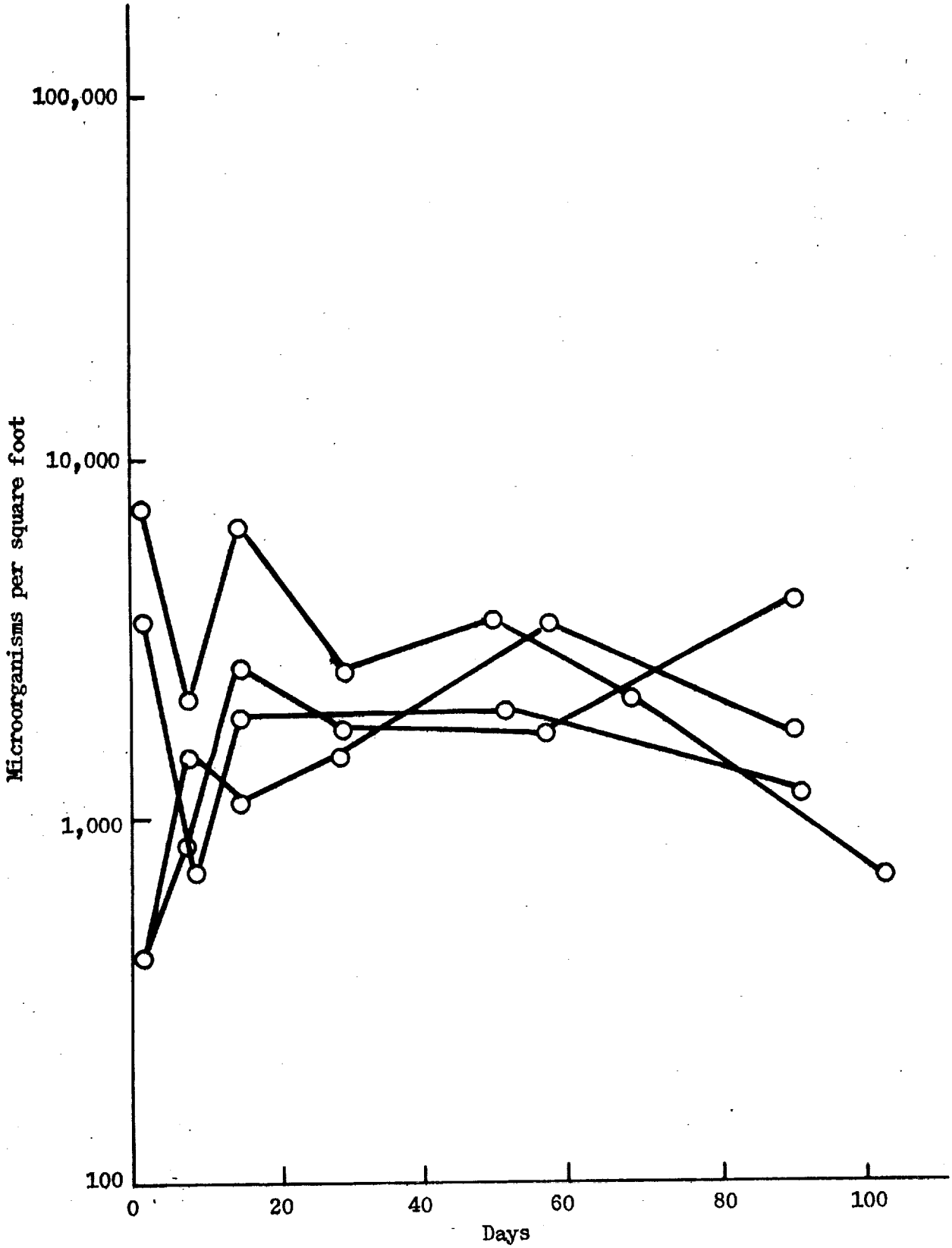

Figure 3. Number of Microorganisms Falling on Surfaces